To help assess their relative ecological roles, cover types were evaluated based on five measures: vegetation structural diversity (vertical [foliage height] and horizontal diversity [patchiness]), plant and animal species richness, and general habitat value for wildlife species characteristic of the particular types. Wildlife habitat value (WHV) was a subjective estimate made on each site observed. Values ranged from a high of five to a low of one (Appendix D). The mean of WHV site estimates within cover types was taken as the value for that type. The other four measures were statistically evaluated. An overall ecological quality rank (EQR) was assigned to the cover types based on the above five measures. A computer evaluation procedure was developed to prescribe indices of range forage production, optimum stocking (carrying capacity) for deer and cattle, and net revenues from hunting-rangeland grazing enterprises (Sheffield, et al., 1995).

FINDINGS AND DISCUSSION

Watershed Cover Types

Five land types, 18 cover types, 5 special attention plant communities, and 2 unique plant communities were encountered (Table 2) and are described below. Time constraints prevented a sufficient number of surveys on some cover types and sub-types for more than subjective assessments. Moreover, satellite imagery on hand did not distinguish certain types. In those cases, related types were grouped. Eight major cover types resulted (Table 3). Of the five ecological measures used to evaluate types, plant structural diversity and species richness statistically explained 86% of the variability (Appendix E). A graphic orientation of the eight types based on their diversity and richness suggested that wetlands (i.e., waterbodies and bottomland hardwood forests) and unmanaged pine-hardwood forests have greater plant diversity and species richness than the other cover types. Merchantable pine forests and pine plantations, cumulatively, are structurally diverse but comparatively poor species-wise.

Table 3. Wildlife habitat value rank (WHV) and ecological quality rank (EQR) of eight major cover types based on five ecological measures. Big Cypress Bayou Watershed ecological reconnaissance, June - October, 1994.[1]

Cover Type	Ecological Measures[1]						
	FHD	HDI	SRP	SRA	WHV[4]	(sum)	EQR[5]
Waterbodied	8.0	7.0	4.0	8.0	7	34.0	1
Bottomland Hardwood Forest	4.0	6.0	8.0	7.0	8	33.0	2
Unmanaged Pine-Hardwood Forest	7.0	4.0	6.0	6.0	4	27.0	3
Shrub-dominated Terraces & Uplands	3.0	2.0	7.0	5.0	5	22.0	4
Old Fields	2.0	3.0	5.0	4.0	6	20.0	5
Managed Pine Forests	6.0	5.0	2.5	2.5	3	19.0	6
Pine Plantations	5.0	8.0	2.5	1.0	2	18.5	7
Pastures and Hay Fields	1.0	1.0	2.5	1.0	1	6.5	8

[1] See Appendix E.
[2] FHD = Foliage height (vertical) diversity
HDI = Horizontal diversity (patchiness)
SRP = Species richness for plants
SRA = Species richness for animals
WHV = Wildlife habitat value
EQR = Ecological quality rank

[3] Includes streams, reservoirs, lakes, ponds, swamps, and marshes.

[4] 8 = highest WHV
[5] 1 = highest EQR

This seemingly incongruous finding is influenced by differences in the age and management of pine stands. Shrub-dominated uplands lack vegetation structural diversity but, because they are rich in plant species, they are used by a high number of animal species. Pastures and hay fields are lowest in diversity and richness of any vegetated Watershed lands. Old fields are more diverse than the other grasslands observed and are intermediate in species richness among all Watershed cover types (Figure 2). A test of dissimilarity based on diversity and richness placed the eight major types into two significantly different (0.05) groups (Table 4). A third group (old fields, managed pine forests, and pine plantations) represents an overlap with the remaining two groups that is not significantly different.

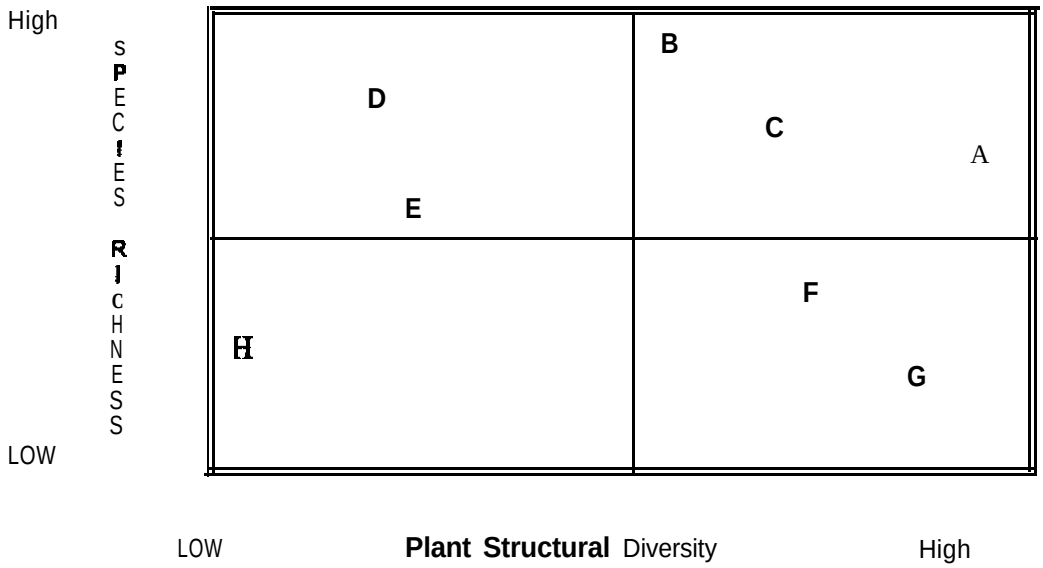

Figure 2. Orientation of eight cover types based on their plant structural diversity and species richness. Big Cypress Bayou Watershed reconnaissance, June - October, 1994.*

* A = Waterbodies
B = Bottomland Hardwood Forests
C = Unmanaged Pine-Hardwood Forests
D = Shrub-dominated Uplands
E = Old Fields
F = Pine Forests
G = Pine Plantations
H = Pastures and Hay Fields

Table 4. Two-way analysis of variance performed on eight cover types across five ecological measures, and Duncan's least significance between type means.

Source of Variation	[1]SS	df	MS	F	P-value	F-crit.
Cover Types	5227.97	7	746.8524	2.2656	0.0584	2.3593
Ecological Measures	21580.639	4	5395.1600	16.3664	5.1E-07	2.71408
Error term	9230.137	28	329.6478			
Total	36038.743	39				

Duncan's Mean Comparison Test[2]

Waterbodies	a	Old Fields	ab
Bottomland Hardwood Forests	a	Managed Pine Forests	ab
Unmanaged Pine-Hardwood Forests	a	Pine Plantations	ab
Shrub-Dominated Uplands	a	Pastures and Hay Fields	b

[1] Statistical parameters are SS: Sum of the squares; df: Degrees of freedom; MS: Mean squares; F: Variance ratio distribution; P-value: Probability value; and F-crit.: Critical variance ratio distribution.
[2] Cover types with different letters are significantly different at the 0.05 level (i.e. the group of 4 followed by the letter "a" is significantly different from the group of 1 (pastures and hay fields) followed by the letter "b." The remaining group of 3, followed by the letters "ab," is intermediate between the other two and not significantly different from either of them.

The reconnaissance gave indices of the characteristic species, the condition, and ecological role of major cover types. Too few observations could be made for reliable assessments of all types. This was the case particularly with aquatic habitats, upland hardwood forests, special attention plant communities, and zones of interface (edge) between types (see **Ecological Considerations and Land Use).** Additional sampling, done seasonally throughout one or more annual cycles, would present ecological conditions and needs more accurately. Given the data in this cursory analysis, and in consideration of ecological concepts, it is not appropriate to state that one cover type has greater ecological value than another.

Identification of all Watershed plant and animal species was beyond the scope of this reconnaissance. Species that characterize the cover types during summer through fall were recorded (Figures 3 and 4; Appendix F). Three hundred and eleven species of plants and 169 species of animals were recorded. The number is roughly 3 1% and 32%, respectively, of the numbers indicated to occur in the Watershed (Campo, 1986; USFWS, 1993). Five of nine special attention plant communities listed as occurring in the Watershed were encountered (Appendix G). The northern river otter, on the Texas Parks and Wildlife Department's Watch List, was found. Special attention species listed for the Watershed (those that are rare, threatened, or endangered) are listed in Appendix H. Bamboo-sweetgum and smooth alder stands were unique communities encountered.

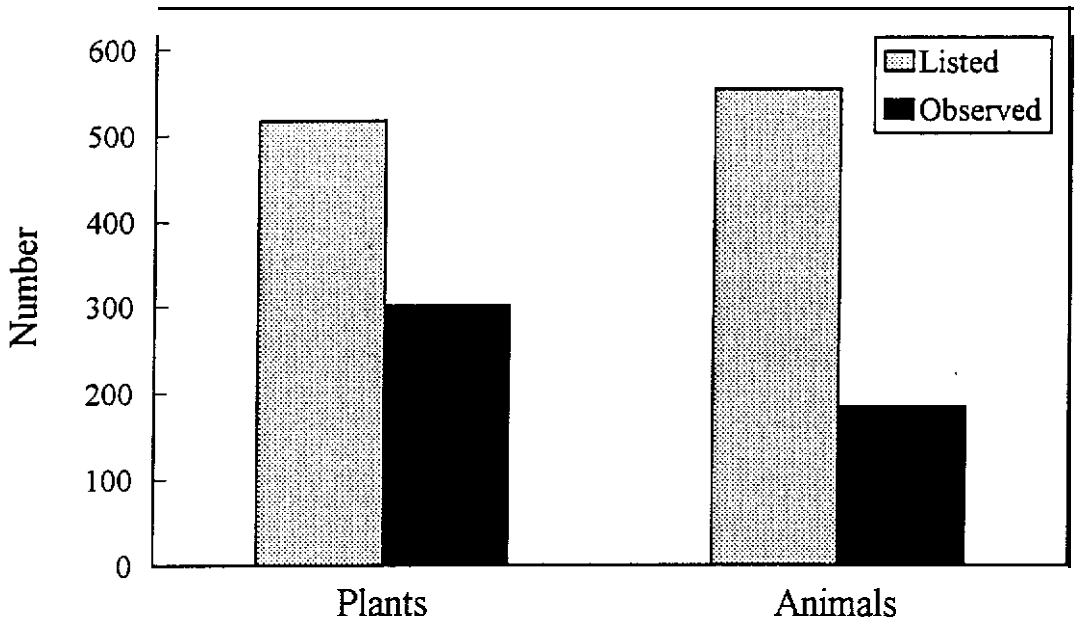

Figure 3. Number of plant and animal species observed during summer - fall vs. the number listed in literature review. Big Cypress Bayou Watershed Reconnaissance, 1994.

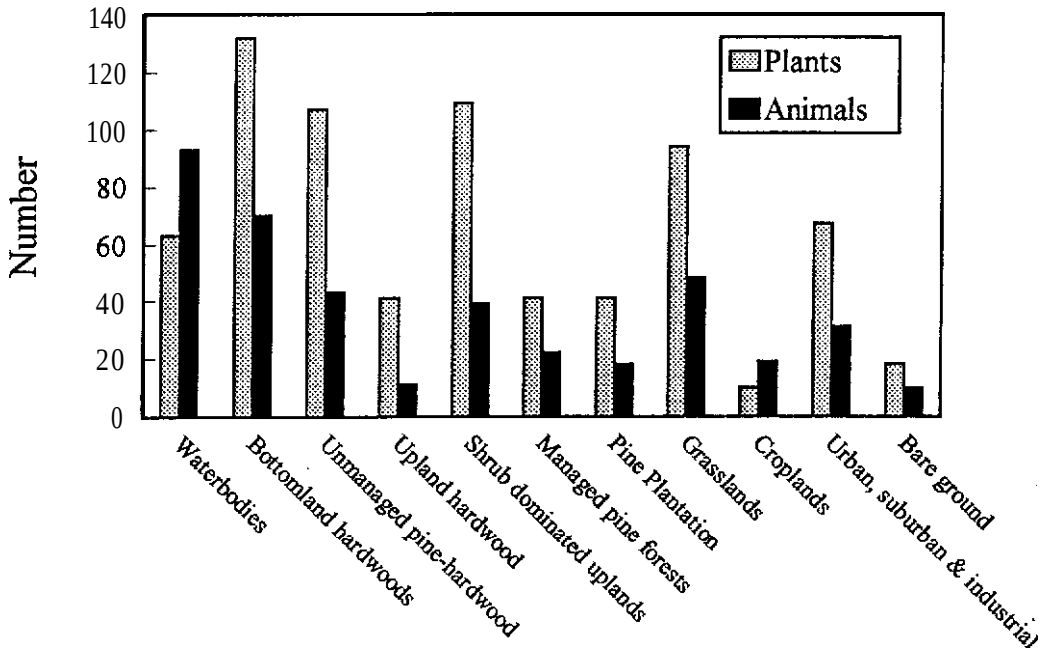

Figure 4. Number of plant and animal species observed by cover types. Big Cypress Bayou Watershed Reconnaissance, June - October 1994.

Waterbodies and Their Perimeters

Cumulatively, waterbodies cover about 3% of the Watershed (Table 5). They support a high diversity of native plants and animals (Appendix F). Waterbodies, together with their riparian zones, have the highest plant structural diversity and species richness of eight types ranked (Figure 2). They were given the highest ecological quality ranking (EQR = 1) and second highest wildlife habitat value ranking (WHV = 7)(Table 3). Only terrestrial species present during tbe summer-fall were considered. Undoubtedly, had the reconnaissance included winter migrants and fishery species, these wetlands would have ranked highest in all evaluations. Sub-types that make up waterbodies are distinctly different ecosystems and are described below.

Table 5. Approximate acreages and percent of the ecological reconnaissance area in major cover types. Big Cypress Bayou Watershed, June - October, 1994.

Cover Types	Acres'	Percent of Total
Waterbodies	76,800	3.0
Bottomland Hardwood Forest.?	435,200	17.0
Unmanaged Pine-Hardwood Forests	768,000	30.0
Managed Pine Forests'	204,800	8.0
Upland Hardwood Forests	102,400	4.0
Shrub-Dominated Uplands'	230,400	9.0
Grasslands	640,000	25.0
Croplands	51,200	2.0
Urban, Suburban, Industrial	25,600	1.0
Bare Ground[5]	25,600	1.0
TOTALS:	2,560,000	100

'Based on a total reconnaissance area of 4,000 mi.[2]
'Includes shrub-dominated floodplain
'Managed natural pine on pine-hardwood type, plus merchantable plantations
'Includes young pine plantations and mixed shrubs to 15 A. tall.
[5]Surfaced roads and devegetated sites.

Streams. These waterbodies begin in the western Watershed as narrow, ephemeral drainages with little or no floodplain. Headwater channels during summer are either dry, have shallow intermittent pools, stagnant standing water, or have sluggish flow (Figures 5, 6, 7, and 8). Occasionally, stream flows are augmented by inflow from springs and beaver ponds. Downstream reaches have pronounced channels with water depths of roughly 2 - 12 ft. and, on average, have much broader floodplains (Figure 9).

Summer-fall vegetation characteristic of riparian zones (stream perimeters) includes hummock sedge, redroot, flatsedge, spike rush, soft rush, broadleaf woodoats, narrowleaf woodoats, switchgrass, lizardtail, false nettle, mint, knotweeds, pennywort, rosemallow, muscadine grape, greenbriars, eardrop vine, climbing hempweed, buttonbush, rattlebush, bagpod, loblolly pine, sweetgum, water oak, sugarberry, winged elm, boxelder, river birch, persimmon, green ash, American holly, and American hornbeam.

Characteristic insects are mosquitos; deer fly; larvae of the caddisfly, damselfly, and skimmers; adult skimmers and dragonflies; water boatman, and water strider. Crayfish (crawfish) and grass shrimp are common crustaceans. Grass pickerel, golden shiner, madtom, black bullhead, bluegill sunfish, redear sunfish, spotted sunfish, mosqnitofish, black-spotted topminnow, and black-stripe topminnow were taken in seine samples. Asiatic clam is the only bivalve of common occurrence on headwater reaches surveyed. One species of mussel (not identified) was encountered. Only the shells of bivalves were found. Ephemeral headwater conditions, exposure to predators, and pollution may be causes for the sparsity of bivalves on headwater reaches. All fishes seined were small. Few game fish were seined. Mud Mle, Texas slider, and red-eared slider are turtles seen. Very few snakes and no amphibians were seen. Snakes included western cottonmouth and broad-banded watersnake. Birds observed were the northern

Figure 5. Narrow channel and floodplain of upper Little Cypress Bayou
Wood County, TX

Figure 6.
Dry headwater channel of Lilly Creek, Upshur County, TX. Household garbage and other solid waste is commonly found at road/stream crossings.

Figure 7. Texas Parks and Wildlife Department biologists setting shallow, intermittent pools. Upper Harmon Bayou: Harrison County, TX

Figure 8. Section of Harrison Bayou, Harrison County, TX with little or no summer water flow. Harrison Bayou, Harrison County, TX.

Figure 9. Down-stream reach of Big Cypress Bayou east of Jefferson, Marion County, TX

cardinal, blue jay, yellow-billed cuckoo, red-bellied woodpecker, downy woodpecker, summer tanager, American crow, and red-shouldered hawk Mammals detected by sightings or signs were raccoon; beaver, river otter, mink, armadillo, white-tailed deer, fox squirrel and gray squirrel. Night observations were. few Those made suggested that barred owl, opossum, mink, and flying squirrel are common nocturnal animals. Signs of river otter and mink were observed rarely and on downstream reaches only. Small rodents were not seen.

Summer habitat quality for the fishery in headwater channels observed appeared very poor to fair and averaged poor Depending on the site, riparian zones were fair to very good and averaged good for terrestrial species. Headwaters surveyed were more often dark colored or sediment laden. Some sites had 6-18 in. of bottom sediment. Occasionally, sediments disturbed during seining emitted the odor of

decaying vegetation. Algal growth, low numbers of specimens in seine samples, and stagnant apparently anoxic water on most headwater reconnaissance sites suggested poor water quality Possible sources of pollution are oilwell locations, timber cutting operations near streams, and stream bank erosion. Point source sewage discharges may occur from numerous residences along Big Cypress Bayou. High volume, short duration releases from Lake 0' The Pines appeared to be contributing to bank erosion of Big Cypress Bayou from immediately below the dam to well down-stream (Figure 10). Substantial bank erosion was seen where upland soils are exposed to water, wind, and wave action. Sudden increase in water levels from reservoir releases may be detrimental to vegetation indigenous to riparian zones and contiguous floodplains (Teskey and Hinckley, 1977) and to mammals that den in stream banks.

Figure 10. Bank erosion on Big Cypress Bayou immediately below Lake 0' the Pines dam, Marion County, TX.

Reconnaissance water quality observations are consistent with findings from detailed water quality studies done by HDR and Price (1994). They reported low dissolved oxygen levels, eutrophic conditions, and high coliform counts in municipal waste discharges. Heavy metals and other pollutants were reported in waterbodies including Big Cypress, Little Cypress, and Black Cypress bayous, the major reservoirs, and Caddo Lake. HDR and Price attributed non-point source pollution to poultry and dairy farming, other agricultural activities, forestry, and oilfield operations. They listed certain industry and the Longhorn Arsenal among sources of heavy metals detected.

Reservoirs. lakes and ponds. Approximately 50,000 ac. of the Watershed are covered by reservoirs. Caddo Lake is about 25,000 ac. The amount of acreage in lakes and ponds on private lands was not determined. Reservoir perimeters adjoin lands that represent most of the cover types identified herein. Reservoir fisheries were not surveyed. Terrestrial species closely associated with these waterbodies are listed in Appendix F.

Caddo is the principal lake in the Watershed (Figure 11). Other lakes, and ponds, are either old oxbows of former stream channels, relatively small, shallow waterbodies created by beaver dams, or they are man-made. Detailed geologic, historical, archaeologic, socio-economic, hydrologic, and ecologic studies of Caddo Lake have been done by private and governmental entities (see **Literature Review).** Most of the lakes and ponds are on private ownerships. This reconnaissance only included terrestrial observations on lake and pond perimeters where there was public access, where special permission was granted, or where observations could be made from public rights-of-way.

Aquatic vegetation characteristic of lakes and ponds includes pondweed, duckweed, water-meal, water-milfoil, water-shield, spatterdock, species of water lily, and water primrose. Emergent perimeter vegetation is water-pepper and other species of smartweed, species of cattail, cutgrass, maidencane, vaseygrass, switchgrass, Walter's millet, eardrop vine, lizardtail, rattlebox, buttonbush, swamp privet, water-elm, and black willow.

Figure 11. Caddo Lake, Clinton Lake component, Marion County, TX.

Characteristic animals are dragonflies, skimmers, bullfrog, turtles (see **Streams**), great blue heron, tricolored heron, black-crowned night heron, great egret, snowy egret, swallows, purple martin, yellow-billed cuckoo, marsh wren, bluejay, red-winged blackbird, red-headed woodpecker, red-bellied woodpecker, belted kingfisher, American crow, wood duck, nutria, beaver, raccoon, and mink Yellow-billed cuckoos and red-headed woodpeckers are declining because of loss of natural habitat and nest cavities in trees (National Audubon Society, 1994). Where artificial nest cavities are not provided, the purple martin is declining as well (National Audubon Society, 1994; Ray 1995)

Swamps Bog- or seep-like swamps associated with narrow floodplain stream reaches, permanently flooded bald cypress stands within the Caddo Lake complex, and bald cypress-water tupelo stands were encountered. Shrub communities occur occasionally along edge between open water and timbered swamp and on intermittently watered depressions (Figures 12 and 13) Beavers have created small shrub swamps by their damming within stream floodplains (Figure 14)

Figure 12. Shrub edge between timbered bottomland and open water. Big Cypress Bayou floodplain, Camp County, TX.

Figure 13. Intermittently watered shrub swamp (background) within the Caddo Lake complex, Marion County, TX.

Figure 14. Shrub swamp created by beaver damming on James Bayou floodplain, Cass County, TX.

Small bog- or seep-like swamps associated with streams and lakes are hydric, periodically inundated sites characterized by peat moss, chain fern, cinnamon fern, netted chain fern, lizardtail, soft rush, spike rush, hummock sedge, broadleaf woodoats, narrowleaf woodoats, black willow, blackgum, green ash sugarberry, sweetgum, willow oak, and water oak

Smooth alder communities are shrub swamps encountered on bog-seep sites associated with streams and lakes (Figure 15) Alder communities are unique and declining. Special attention swamp communities encountered are bald cypress and bald cypress-water tupelo swamp These communities are discussed below

Plants common on shrub swamps within cypress stands and on floodplain depressions are water-elm, swamp privet, buttonbush, and bald cypress Fish spider, yellow-throated warbler, parula warbler, belted kingfisher, fish crow, double-crested cormorant, wood duck, raccoon, nutria, and beaver are animals encountered American alligator is reported in the Caddo Lake swamp and other Watershed

wetlands, but was not seen. Turtles seen are listed in Appendix F. Although sites observed appeared suitable habitat for species of water snakes, none were seen. Representative terrestrial animals are similar to species listed below under **Bottomland hardwood forests**.

Figure 15. Alder-dominated shrub swamp associated with a branch of Mill Creek, Cass County, TX.

Marshes. Few marshes were encountered Most of those observed are small (2-10 ac) wetlands crcntcd by beaver damming along stream reaches. or that have evolved randomly along the edge of reservoirs (Figures 16 and 17) Larger marshes observed are grass-dominated wetlands (50-100+ ac) in the eastern end of the Watershed (Figure 18) Both types make important contributions to the Watershed's ecological integrity (see **Ecological Considerations and Land Use).**

Most of the mnrshcs created by beaver dams have standing dead timber. Grasses and grasslike plants are predominately scdgcs, spikesedges, cutgrass, and Walter's millet. Buttonbush is the most

Figure 16. Marsh created by beaver damming on a branch of Black Bayou, Miller County, AR.

Figure 17. Marshy edge on Lake O' the Pines, Marion County, TX

Figure 18. **Large** marsh associated with Black Bayou east of Oil City, Caddo Parish. LA

common shrub. Dead standing timber provides nest sites for red-headed woodpecker, red-bellied woodpecker, and wood duck. In addition, great blue heron, tricolored heron, brown-headed nuthatch, American rough-winged swallow, cliff swallow, barn swallow, purple martin, red-shouldered hawk, American crow, bluejay, marsh wren, and Carolina wren are summer birds seen on beaver marshes.

Larger grass-dominated marshes are characterized by maidencane, cutgrass, and cattail. Other characteristic plant species are rushes, smartweeds, buttonbush, and black willow. Characteristic animals are mosquitos, dragonflies, mosquito fish, common carp, turtles, red-bellied water snake, red-winged blackbird, green heron, belted kingfisher, nutria, and raccoon. American alligator and cottonmouth are known to occur on the marshes but were not seen. Signs of beaver, raccoon, and white-tailed deer indicated that they are common marsh mammals. American bittern pintail, not encountered during this reconnaissance, relies heavily on freshwater marshes. They are declining, in part because of the loss of marsh habitat (National Audubon Society, 1994).